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Brief

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Missouri High Performance Concrete Update

Missouri Completes First High Performance Concrete Prestress I-Girder Fabrication

In 1996, Missouri volunteered to participate as a lead state in the AASHTO Lead State Program for High Performance Concrete. The lead state program was initiated in 1996 by the AASHTO Task Force on SHRP Implementation in an effort to implement specific "high payoff" SHRP technologies such as high performance concrete. High performance concrete (HPC) technology utilizes innovative design and construction concepts for improved pavements and bridges. As a result, pavements and bridges are constructed having longer service lives with improved performance and greater economic benefits. As a lead state in HPC technology, Missouri is committed to help further the development and implementation of HPC.

Research Development and Technology Division

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Project Description:

Missouri recently completed the fabrication of the state's first high performance concrete (HPC) prestress I-girders. The HPC I-girders were fabricated by Egyptian Concrete Co. in BonneTerre, Missouri and will be used in the 4-span, Route 21 N.B.L. bridge over Route M in Jefferson County. A design strength of 10,000 psi at 56 days in the prestress I-girders was used as opposed to a 5000 psi design strength typically used. As a result of the increased strength, the bridge requires only five girders per span instead of six, with the spacing between the girders increasing from 8'8" to 10'10". Construction of a companion structure, the Route 21 S.B.L. bridge over Route M, which utilizes conventional concrete in the prestress I-girders will allow comparison of the durability and in-service performance of the HPC I-girders versus the conventional mix I-girders.

Fabrication:

Fabrication of the HPC prestress I-girders went as scheduled with minimal problems. Even though casting took place during some of the hottest temperatures of the summer, the fabricator was able to maintain controlled temperatures throughout operations by scheduling early a.m. pours, using chilled water, shaded aggregates, and fabricating in a housed environment.

The HPC mix, using Type I cement with silica fume and having a low design water-to-cementitious material (W/CM) ratio of 0.240, produced strengths well over 10,000 psi. Strengths up to 11,500 psi at 3 days were reported. The addition of a high range water reducer (HRWR) to the mix enabled the fabricator to

maintain the low W/CM ratio while producing a mix that was workable and placeable. The mix was also air-entrained with air contents averaging 5.4% throughout fabrication. Tighter specifications, minimizing allowable tolerances and necessitating excellent quality control, and a cooperative effort between the fabricator and representatives from W.R. Grace, River Cement Company and MoDOT made for an overall successful operation.

Project Research:

Research on the HPC project has been a joint effort between MoDOT and the University of Missouri at Columbia (UMC). Project research includes laboratory testing of specimens collected during fabrication, as well as, instrumentation and monitoring of the I-girders immediately following casting and while in-service. Laboratory testing includes the following:

- compressive strength up to 1 year
- creep
- shrinkage
- modulus of elasticity
- rapid chloride permeability
- freeze-thaw durability
- air-void analysis

Instrumentation of the I-girders for strain and temperature data will provide information concerning the general behavior of HPC prestress I-girders and its creep, shrinkage, and thermal effects on prestress losses over time.

Test specimens have also been collected during fabrication of the prestress I-girders using conventional concrete also produced by Egyptian Concrete Company. Laboratory testing will include the same testing as that for the HPC specimens. Actual comparisons can then be made to determine the extent of enhancements in HPC versus conventional mix.

After complete construction of both the bridge with the HPC I-girders and the companion bridge with the conventional I-girders, a field performance program will be initiated to monitor and compare the performance of the structures on an on-going basis

Project Costs and Benefits:

The use of HPC in the I-girders eliminated one girder line in the bridge superstructure which saved in the fabrication of twenty I-girders instead of twenty-four. As expected, the initial costs of the HPC I-girders per linear foot were higher (approximately 39%) when compared to the cost of the conventional I-girders. This increased initial cost may not only be attributed to the increased cost of producing a higher quality mix, but also due to the fact that it's a new technology which would appear to pose some risk. Overall benefits of the HPC, though, should be demonstrated by the significant long term savings produced as a result of its improved durability and less maintenance and repair required over a longer service life. In addition, this project proved that HPC in structures is an viable concept in Missouri, and that it has much potential for improving Missouri's bridge design and construction methods.

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